**LIPA: LUNAR ICE PERCEPTION ALGORITHM** A. Slabic[1], J. M. Rollins[1], and S.R. Pomajevich[1]. Astromaterials Research and Exploration Science Division, Jacobs Technology, NASA Johnson Space Center, Houston, TX.

**Introduction:** The highest concentration of Lunar water-ice stores exists within the Permanently Shadowed Regions (PSRs) of the Lunar South Pole [1-3]. As such, the ability to locate *in situ* water-ice stores in an accurate, systematic, and safe manner will prove vital for future Lunar activities which rely on hydrogen-based resources. Here we show how the strong absorptive properties of ice can be exploited so that surface ice located in PSRs can be easily differentiated from the surrounding frozen regolith.

Testbeds which simulate an icy lunar landscape were created and then systematically imaged using a mid-wave infrared (MWIR) camera system. Testbeds were imaged under two filter modes (1) high-absorption (high-abs) mode: whereby imagery captured were confined to a single central wavelength (CWL) of 3.15 ± 0.03 µm and (2) low-absorption (low-abs) mode: whereby imagery captured were confined to a single CWL of 3.80 ± 0.04 µm (Figure 1). High- and low-absorption modes are related to the absorptive properties of ice at each selected wavelength, respectively.

Corresponding images from each filter mode were differenced (i.e., pixels were subtracted) to enhance contrast between ice-bearing and non-ice-bearing pixels, and then fed into a semantic segmentation model. The model was trained to detect and differentiate between water, ice, shadows, and lunar regolith.

**Results:** Modeling results accurately discriminated ice from other materials (such as frozen lunar regolith) and were used to visually resolve the spatial extent of surface ice. Further, outputs produced through semantic segmentation were used to estimate water-ice contents in collected imagery [(Pixels with Class = "Water Ice")/(Sum of Pixels)*100].

**Summary:** These works prove promising for future in situ resource utilization (ISRU) missions which employ robotics in combination with infrared camera systems to advance science objectives (e.g., locate water-ice in frozen regolith) on the lunar surface.

**References:** [1] Cannon K. M., Deutsch A. N., Head J. W., and Britt D. T. (2020) *Geophysical Research Letters*, 46, e2020GL088920. [2] Honniball C. I. et al. (2021) *Nature Astronomy* 5, no. 2, 121-127. [3] Li S. et al. (2018) *Proceedings of the National Academy of Sciences*, 115(36), 8907-8912.

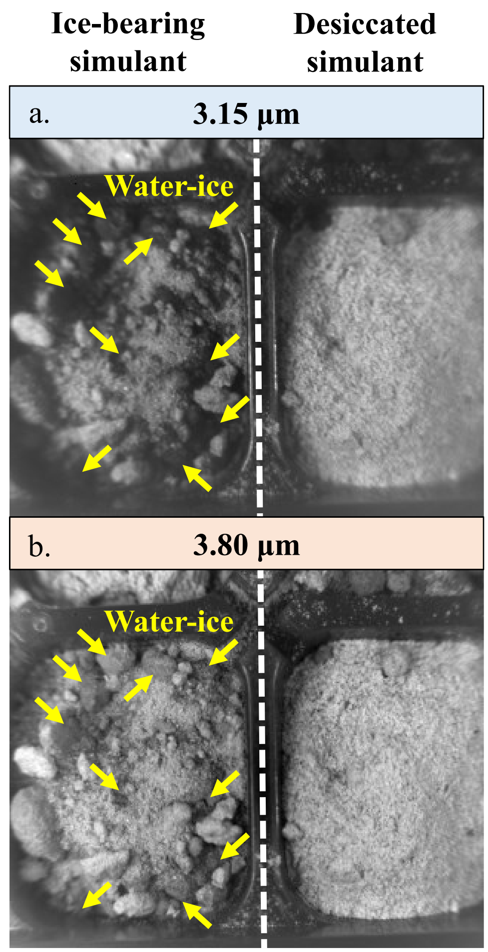


**Figure 1.** Corresponding Medium-wave infrared (MWIR) camera images of ice-bearing lunar highland simulant (shown left) and desiccated lunar highland simulant (shown right). Infrared images shown in (a.) were captured with a 3.15 ± 0.03 µm optical filter ("high-absorption") while images shown in (b.) were captured with a 3.80 ± 0.04 µm optical filter ("low-absorption"). Water-ice zones are denoted by yellow arrows. Note that desiccated lunar highland simulant cannot be differentiated between the two chosen bands (i.e., desiccated simulant appears the same under both filter modes), while water-ice is greatly enhanced under the high-absorption band (i.e., water-ice appears black under 3.15 µm band versus light grey under 3.80 µm).